Instruction Manual

JOHN FLUKE MFG. CO., INC.

ELECTRONICS FOR INDUSTRY

Preliminary Instruction Manual

for

FLUKE MODELS 891A & 891AR

DC DIFFERENTIAL VOLTMETER

INSTRUMENTS / COMPONENTS

Serial No. 123 and above

JOHN FLUKE MFG. CO., INC.

P. O. Box 7428, Seattle, Washington 98133

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DC DIFFERENTIAL VOLTMETER

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SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. The Model 891 DC Differential Voltmeter is a completely solid-state voltage measuring instrument capable of performing voltage measurements, as either a conventional dc voltmeter or more accurately as a dc differential voltmeter, from 0 to ±1100 volts dc.

1-3. The Model 891 is manufactured in two different forms. One form is a portable unit, approximately half rack size in width, with a large carrying handle that can be used as a tilt bale for bench or field use. This unit is designated, the Model 891A. The other form is also a portable unit for bench and field use, but is particularly applicable for rack mounting. This unit is designated, the Model 891AR.

1-4. Two options, initially installed or added later, are available for the Models 891A and 891AR. These options are a rechargeable battery pack, designated -01, and a recorder output module, designated -02. Instruments containing both options are designated -21. A metal decal, located on the rear panel of the instrument, will indicate the option(s) contained in the instrument, such as 891A-01.

1-5. ELECTRICAL SPECIFICATIONS

1-6. DIFFERENTIAL VOLTMETER

ABSOLUTE ACCURACY
±(0.02% of input +0.001% or range +10 uv) from 0 to 1100 volts dc, from 10° C to 40° C (50° F to 104° F).

INPUT AND NULL RANGES

Input Ranges (volts)	Null Ranges (volts)
1	0.001, 0.01, 0.1
10	0.001, 0.01, 0.1, 1
100	0.01, 0.1, 1, 10
1000	0.1, 1, 10, 100

INPUT RESISTANCE
Infinite at null from 0 to 1100 volts dc.

METER RESOLUTION

Input Ranges (volts)	Maximum	Resolution
	ppm of range	voltage
1	10	10 uv
10	1	10 uv
100	1	100 uv
1000	1	1 mv

VOLTAGE DIAL RESOLUTION

Input Ranges (volts)	Resolution	
	ppm of Range	voltage
1	10	10 uv
10	10	100 uv
100	10	1 mv
1000	10	10 mv

1-7. CONVENTIONAL VOLTMETER

ACCURACY
±3% of RANGE.

RANGES AND INPUT RESISTANCE

Input Ranges (volts)	Input Resistance (megohms)
1000-0-1000	100
100-0-100	100
10-0-10	100
1-0-1	100
*0.1-0-0.1	100
*0.01-0-0.01	10
*0.001-0-0.001	10

NOTE: 10% over-ranging capability on each range.

* These ranges obtained using null ranges with all readout dials at zero.

1-8. GENERAL

ELECTRICAL DESIGN
Completely solid-state.

INPUT RESISTANCE OF NULL DETECTOR
100 megohms on all ranges except 10 megohms on the 0.01 and 0.001 voltage ranges.

REFERENCE ELEMENT
Temperature compensated zener diodes.

REGULATION OF REFERENCE SUPPLY
0.0005% for a 10% line voltage change.

STABILITY OF REFERENCE SUPPLY
0.0015% peak-to-peak per hour
0.0025% peak-to-peak per day
0.0040% peak-to-peak per month
0.0075% peak-to-peak per year

INSTRUMENT STABILITY
0.0015% peak-to-peak per hour
0.0025% peak-to-peak per day
0.0048% peak-to-peak per month
0.0090% peak-to-peak per year

(NOTE: Stability per year is sufficient to permit the instrument to meet all specifications when calibrated only once per year.)

KELVIN-VARLEY DIVIDER ACCURACY
±0.005% of dial setting above 1/10 of full scale.

RECORDER OUTPUT
Available as an option, adjustable from 0 to ±0.2 volts for end scale null deflection. Low side grounded. Loading does not affect null deflection accuracy.

POLARITY
Reversible via front panel switch.

WARMUP TIME
Less than 1 minute.

DC COMMON MODE REJECTION
120 db (1 uv/volt of common mode voltage).

AC COMMON MODE REJECTION
Up to 100 volts peak-to-peak, 50 to 500 Hz, produces no measurable instrument error.

SHOCK
Meets requirements of MIL-T-945A and MIL-S-901B.

VIBRATION
Meets requirements of MIL-T-945A.

INPUT POWER
115/230 volt ac ±10%, 50 to 500 Hz, approximately 4 watts for line operation and a total of approximately 8 watts while charging batteries.

1-9. ENVIRONMENTAL SPECIFICATIONS

OPERATION TEMPERATURE RANGE
Within accuracy specification from 10° C to 40° C (50° F to 104° F), derated at 15 ppm/° C outside these limits to 0° C and 50° C (32° F and 122° F).

HUMIDITY
Within specifications up to 70% relative humidity.

STORAGE TEMPERATURE
Model 891A (line power only) -40° C to 70° C (-40° F to 158° F)
Model 891A (line power with rechargeable batteries) -40° C to 60° C (-40° F to 140° F).

1-10. MECHANICAL SPECIFICATIONS

MOUNTING
Model 891A - Tilt down carrying handle which detents into the plastic front feet for use as a tilt bale.
Model 891AR - Tilt bale and plastic feet for bench and portable use plus mounting flanges for installation in standard EIA relay rack. Also includes provisions for installation of chassis slides.

SIZE
Model 891A - 8-1/2" wide by 7" high by 12-1/4" deep.
Model 891AR - 17" wide by 3-1/2" high by 12-1/4" deep. (The width, after installation of mounting flanges, is 19".

WEIGHT
Model 891A — Approximately 12 lbs.
Model 891AR — Approximately 12 lbs.
Battery Power Pack — Approximately 2 lbs.
Recorder Output Module — Approximately 0. 3 lbs.

SECTION II

OPERATING INSTRUCTIONS

2-1. PRELIMINARY INSTRUCTIONS

2-2. INPUT POWER

2-3. The Models 891A and 891AR are equipped with a slide switch (located on the rear panel) to connect the primary windings of the power transformer in the proper arrangement for either 115 volt ac or 230 volt ac line operation. For proper instrument operation, this switch should be placed in the position corresponding to your power requirements.

NOTE!

The round pin on the polarized three-prong plug of the line cord connects the power line ground to the chassis of the Model 891. When connecting the line cord to a two contact power line recepticle, use a two-to-three-prong adapter. For personal safety connect the wire lead of the adapter to a suitable ground.

2-4. CONTROLS, TERMINALS, AND INDICATORS

2-5. The name, circuit symbol, and function of the front panel controls, terminals and indicators of the Models 891A and 891AR may be found in Figure 2-1. Name, circuit symbol, and function of the rear panel controls, terminals, and indicators of the Models 891A and 891AR may be found in Figure 2-2.

NAME	CIRCUIT SYMBOL	FUNCTION
INPUT	J1 (HI) and J2 (LO)	The HI and LO terminals are provided for connection of the dc voltage to be measured.
Chassis Ground ⏚	J3	Chassis ground terminal (black). The LO INPUT terminal is isolated from chassis ground by a 100 megohm resistor in parallel with a 0.047 microfarad capacitor. Should it become desireable to connect the chassis ground terminal to the LO INPUT terminal, use the shorting link connected to the chassis ground terminal for this purpose.
POWER Switch	S2	The POWER switch applies ac line power to the primary of the power transformer to energize the instrument when turned from the OFF to the ON position. The POWER switch, for units equipped with the optional rechargeable battery pack, utilizes five positions. When turned from the OFF to the LINE OPR position, the unit is energized by ac line power. While in the LINE OPR position, the batteries are trickle charged to keep them in a fully charged condition during extended periods of line operation. Full battery charging is accomplished when the unit is operated from line power in the BAT CHG-LINE OPR position. In the BAT CHK position, the front panel meter indicates the charge condition of the battery pack. If the meter needle indicates to the right of the -0.2 volt point on the meter scale, the batteries should be recharged (full charge is obtained in 16 hours). The BAT OPR-LINE ISOL position opens both sides of the power transformer primary circuit and allows the instrument to operate on battery power only. Thus isolation of the instrument from the power line is accomplished. However, to achieve chassis isolation from the power line ground, the instrument's line cord must be disconnected.

Figure 2-1. DESCRIPTION OF FRONT-PANEL CONTROLS, TERMINALS, AND INDICATORS (continued)

NAME	CIRCUIT SYMBOL	FUNCTION
RANGE Switch	S1	The RANGE switch allows selection of the appropriate input voltage range, while simultaneously positioning the decimal point for the front panel readout dials and selecting the proper set of NULL SENS ranges.
NULL SENS Switch	S3	Allows the instrument to function as either a conventional voltmeter, in the TVM (transistor voltmeter) position, or as a differential voltmeter in the various full scale null detector sensitivity ranges.
Readout Dials	S5 thru S7 and R37	Provides an in-line readout of the unknown voltage, when at a final balanced condition in the differential mode of operation.
Meter	M1	A center-scale-zero meter that indicates the unknown voltage when in the TVM mode of operation. In the differential voltmeter mode of operation, the meter indicates the difference between the unknown voltage and the reference supply voltage, of the Model 891, selected with the readout dials.
Mechanical Zero	none	Located at the center of the lower portion of the NULL SENS bezel on the Model 891A, and just below the meter of the Model 891AR. This adjustment allows mechanical placement of the meter needle over the zero position on the meter scale. The adjustment should be made only after the instrument has been off for at least 3 minutes.

Figure 2-1. DESCRIPTION OF FRONT-PANEL CONTROLS, TERMINALS, AND INDICATORS (continued)

NAME	CIRCUIT SYMBOL	FUNCTION
POLARITY Switch	S4	Allows polarity selection of the internal reference supply output for comparison with the unknown voltage, in the differential voltmeter mode of operation. With the POLARITY switch in the + position, the polarity of the HI INPUT terminal is positive with respect to the LO INPUT terminal. When the POLARITY switch is in the - position, the polarity of the HI INPUT terminal is negative with respect to the LO INPUT terminal.

Figure 2-1. DESCRIPTION OF FRONT-PANEL CONTROLS, TERMINALS, AND INDICATORS

NAME	CIRCUIT SYMBOL	FUNCTION
Power Connection Jack	J4	Allows connection of the line cord (supplied with the Model 891) which in turn is connected to an ac power line source.
Fuse	F1	F1, a 1/8 ampere slow blowing fuse, provides overload protection for the instrument. The fuse is electrically located in the high side of the power transformer's primary circuit and physically located in the fuse holder on the instrument's rear panel.
115/230 Power Switch	S5	With the switch in the 115 position, the primary windings of the dual primary power transformer are connected in parallel for 115 volt ac operation. When the switch is placed in the 230 position, the primary windings of the power transformer are connected in series for 230 volt ac operation.

Figure 2-2. DESCRIPTION OF REAR - PANEL CONTROLS, TERMINALS, AND INDICATORS (continued)

NAME	CIRCUIT SYMBOL	FUNCTION
*RECORDER OUTPUT Terminals	J5 (HI) and J6 (LO)	These terminals are provided for connection of an external recording instrument. The LO RECORDER OUTPUT terminal is connected to the chassis ground of the Model 891.
*RECORDER OUTPUT Level Control	R10	The level control varies the RECORDER OUTPUT volts from 0 to ±0.2 volts dc, for a full-scale deflection in the differential mode of operation. This control is located below the RECORDER OUTPUT terminals.
* Part of the optional Recorder Output Module.		

Figure 2-2. DESCRIPTION OF REAR - PANEL CONTROLS, TERMINALS, AND INDICATORS

2-6. BATTERY CHECK

2-7. The battery charge condition should be checked before operating a Model 891 from battery power only. The following procedure should be used to check battery charge:

a. Turn the POWER switch to BAT CHK.

b. The meter needle should deflect to the left of the -0.2 volt point on the meter scale for an acceptable battery charge indication.

c. If battery charge is acceptable, turn the power switch to the BAT OPR position and allow approximately 1 minute to warmup before proceeding with measurements. If battery charge is not acceptable, refer to step d for recharging information.

d. To recharge the batteries, connect the instrument to a power line source and turn the POWER switch to the BAT CHG position. Allow 16 hours for a full charge.

2-8. INSTRUCTIONS

2-9. OPERATION AS A CONVENTIONAL VOLTMETER

2-10. The Model 891A, or 891AR, may be used as a conventional voltmeter with a ±3% of range accuracy. To operate the instrument as a conventional voltmeter, proceed as follows:

a. Apply power to the Model 891 and allow approximately 1 minute to warm up. For battery powered operation, complete the battery check of paragraph 2-6.

b. Refer to Figure 2-3 and set the RANGE switch, NULL SENS switch, readout dials, and POLARITY switch in accordance with the full-scale voltage range desired. If the approximate value of the voltage to be measured is unknown, initially select the 1000 volt range.

c. Connect the voltage to be measured between the HI and LO INPUT terminals. If one side of the voltage source is grounded, connect the grounded side to the LO INPUT terminal.

d. Decrease the range setting until the meter deflection is as close to end scale as possible.

e. To determine the value of the voltage being measured, multiply the voltage point indicated on the meter by the range selected and affix to this value the polarity sign corresponding to the direction of the meter needle deflection.

FULL-SCALE DEFLECTION	RANGE SWITCH	NULL SENS SWITCH	READOUT DIALS	POLARITY SWITCH
1000-0-1000	1000	TVM	No Effect	+
100-0-100	100	TVM	No Effect	+
10-0-10	10	TVM	No Effect	+
1-0-1	1	TVM	No Effect	+
.1-0-.1	1	.1	All Zero	+
.01-0-.01	1	.01	All Zero	+
.001-0-.001	1	.001	All Zero	+

Figure 2-3. RANGES AND CONTROL SETTINGS FOR OPERATION AS A CONVENTIONAL VOLTMETER

2-11. OPERATION AS A DIFFERENTIAL VOLTMETER

2-12. The Model 891A, or 891AR, may be used as a differential voltmeter with an accuracy better than 100 times that attainable as a conventional voltmeter. To operate the instrument as a differential voltmeter, proceed as follows:

a. Apply power to the Model 891 and allow approximately 1 minute to warm up. For battery powered operation, complete the battery check of paragraph 2-6.

b. RANGE switch to 1000.
NULL SENS switch to TVM.
POLARITY switch to +.

c. Connect the voltage to be measured between the HI and LO INPUT terminals. If one side of the voltage source is grounded, connect the grounded side to the LO INPUT terminal.

d. Should the meter needle deflect to the - (left) side of the meter scale, place the POLARITY switch in the - position. This will cause a deflection to the + (right) side of the meter scale, which indicates that the internal reference supply of the Model 891 is in the proper polarity for comparison with the unknown voltage.

e. Set the RANGE switch to the lowest range that will allow an on scale deflection, and note the approximate value of the voltage being measured. (If necessary, refer to step e of paragraph 2-8 to determine this value.)

f. Adjust the readout dials to the approximate value determined in step e.

g. Place the NULL SENS switch to successively higher null detector sensitivities while adjusting the readout dials to keep the meter needle within ± 1 major scale division of the center scale, zero, position.

h. When the highest null detector sensitivity is reached, adjust the readout dials for an exact zero position of the meter needle.

i. The value indicated on the readout dials is now the exact value of the voltage being measured with a polarity as indicated by the position of the POLARITY switch.

2-13. OPERATION WITH A RECORDER

2-14. The following instructions apply only to the Models 891A and 891AR containing the recorder output option. To use the Model 891 with a recorder for monitoring a voltage or voltage excursions, proceed as follows:

a. Apply power to the Model 891 and allow approximately 1 minute to warm up. For battery powered operation, complete the battery check of paragraph 2-6.

b. Connect the recorder to the RECORDER OUTPUT terminals. The LO RECORDER OUTPUT terminal is connected to the Model 891's chassis.

c. Short the HI and LO INPUT terminals of the Model 891, and set the front panel controls as follows:

RANGE	10
Readout Dials	1.0 0 0 0
NULL SENS	1
POLARITY	+

d. The meter will indicate full-scale, -1. This full-scale deflection provides up to 0.2 volts dc at the RECORDER OUTPUT terminals, depending on the setting of the output level control (located just below the RECORDER OUTPUT terminals).

e. Adjust the RECORDER OUTPUT level control to produce the desired recorder deflection for the full-scale meter deflection.

f. Remove the short between the HI and LO INPUT terminals.

g. Set the front panel controls of the Model 891 as follows:

RANGE	1000
NULL SENS	TVM

h. Connect the voltage source to be monitored to the HI and LO INPUT terminals of the Model 891. If one side of the voltage source is grounded, connect the grounded side to the LO INPUT terminal.

i. Set the RANGE switch to the lowest range that will allow an on-scale meter deflection. If this deflection is to the - (left) side of the meter scale, set the POLARITY switch to the - position. This will cause the deflection to be to the + (right) side of the meter scale.

j. Adjust the readout dials to the exact desired value, if known. Should the value be unknown, determine the exact value or nominal value, if varying, from the positive deflection in step i. Adjust the readout dials to this value.

k. Set the NULL SENS switch to the highest null detector sensitivity that will allow the voltage or voltage excursions to remain on scale.

l. The recorder should now be properly monitoring the voltage or voltage excursions indicated on the meter of the Model 891. The full-scale meter deflection (1), left or right, is equal to the NULL SENS range being used. Meter deflection to the right of zero indicates that the voltage being monitored has increased above the nominal value indicated on the readout dials. Deflection to the left of zero indicates that the voltage has decreased below this nominal value.

2-15. SERVICING INFORMATION

2-16. The John Fluke Manufacturing Co., Inc. warrants each instrument manufactured by them for the period of one year upon making delivery of the instrument to you, the original purchaser. Complete warranty information is contained in the Warranty page located at the rear of this manual.

2-17. If you should encounter any problem in the operation of your instrument, please feel free to contact your nearest John Fluke Sales Representative or write directly to the John Fluke Manufacturing Co., Inc. with a statement of your problem.

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

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